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Applicant(s): Gallagher et al.

Docket No.

BUR920030178US1

Application No.
10/709,733

Filing Date
May 25, 2004

Examiner
S. Rosasco

Customer No.
29154

Group Art Unit
1756

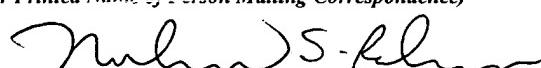
Invention: **LIGHT SCATTERING EUVL MASK**

I hereby certify that this **DECLARATION UNDER 37 C.F.R. 1.131**
(Identify type of correspondence)

is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)] on
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:
Gallagher et al.

Serial No.: 10/709,733

Filed: May 25, 2004

Group Art Unit: 1756

Examiner: Rosasco, Stephen D.

Atty. Docket No.: BUR920030178US1

For: LIGHT SCATTERING EUVL MASK

Commissioner of Patents
P.O. BOX 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 C.F.R. §1.131

We, the inventors of the invention defined by claims 1-48 of U.S. Patent Application Serial No. 10/709,733 hereby declare the following:

[0001] The purpose of this declaration is to prove that we conceived the claimed invention prior to the earliest effective prior art date of U.S. Patent Publication No. 2005/0250019 published to Lin, which is presently understood to be May 4, 2004 and U.S. Patent Publication No. 2004/0126673 published to Udagawa, which is presently understood to be August 29, 2003. The following shows that we conceived our invention prior to August 29, 2003 and that we were diligent from our date of conception to its reduction to practice and were further diligent to the date of the filing of our patent application, which has a filing date of May 25, 2004 (hereinafter referred to as the "Patent Application").

[0002] We are all the inventors of the subject matter claimed in claims 1-48 of U.S. Patent Application Serial No. 10/709,733.

[0003] During all time periods mentioned herein, and specifically between our conception date and the filing date of the application, all activities described herein occurred in the United States.

[0004] Proof of the conception of the claimed invention prior to August 29, 2003, and diligence in reducing the invention to practice and filing the Patent Application is demonstrated in the attached Exhibit, labeled as Exhibit A.

[0005] As shown in Exhibit A, which is an invention disclosure form typically used by our employer and designated Assignee, International Business Machines Corporation, we conceived the claimed invention at a date prior to August 29, 2003. As permitted by MPEP §715.07, the dates on Exhibit A have been removed; however, we hereby declare that all dates corresponding to the conception date and reduction to practice occurred prior to August 29, 2003. Further, the invention was actually conceived before Exhibit A was prepared. Therefore, our conception date actually predates Exhibit A.

[0006] Exhibit A specifically discloses the claimed invention as defined by the independent claims. For example, independent claim 1 defines an extreme ultraviolet lithography mask comprising an ultraviolet reflective region; and an ultraviolet scattering region,

wherein said reflective region and said scattering region are comprised of a same material.

Independent claim 8 defines a radiation scattering reflective mask comprising an ultra low expansion substrate; a crystalline silicon layer adjacent to said ultra low expansion substrate; and a multilayer comprising molybdenum and silicon adjacent to said crystalline silicon layer, - wherein said multilayer comprises a surface having level portions and uneven portions.

Independent claim 18 defines an extreme ultraviolet lithography mask comprising a substrate; a crystalline silicon layer over said substrate; and a multilayer comprising molybdenum and silicon over said crystalline silicon layer, wherein said multilayer comprises a reflective region and a scattering region. Independent claim 27 defines a method of forming an extreme ultraviolet lithography mask, said method comprising bonding a crystalline silicon layer adjacent to a substrate; and forming a multilayer comprising molybdenum and silicon adjacent to said crystalline silicon layer, wherein said multilayer comprises surface having level portions and uneven portions. Independent claim 43 defines a method of forming an extreme ultraviolet lithography mask, said method comprising forming reflective regions on surfaces of said mask; and forming scattering regions on said surfaces of said mask, wherein said reflective regions and said scattering regions comprise a same material. Exhibit A clearly describes the above features (and in particular, the Background Section, Summary Section, and Description Section provided on pages 6-8 of Exhibit A) and provides illustrations (Figures 1 through 4) corresponding to these features as well. In fact, the descriptions and illustrations provided in pages 6-8 of Exhibit A served as the basis for the specification, drawings, and claims of the Patent Application. The features provided in dependent claims 2-7, 9-17, 19-26, 28-42, and 44-48 are generally inferred in Exhibit A.

[0007] We were diligent from the date of conception in reducing the invention to practice and in pursuing, preparing, and filing the Patent Application. More specifically, on December 15, 2003, information similar to that shown in Exhibit A was presented to a patent attorney to determine whether a patent application should be prepared.

[0008] Generally, the invention was conceived on or about February 1, 2003 and was reduced to practice on or about May 23, 2003. An exhaustive series of experiments were conducted on the invention testing its validity from February 1, 2003 to May 23, 2003. The testing was quite rigorous and required substantial time, money, and effort to undertake. The results of the experiments were positive, which further resolved the decision to seek patent protection. After the invention was conceived and reduced to practice, and the testing yielded positive results, the decision was reached to seek patent protection due to the potential commercial value and prestige afforded by the claimed invention as well as the results of a prior art search. On December 13, 2003, a patent attorney was instructed to prepare a patent application that eventually became the Patent Application. The Patent Application was eventually prepared and filed on May 25, 2004.

[0009] The foregoing declarations are made according to we best recollection upon review of the appropriate documents and notes, and I hereby acknowledge that willful false statements and the like are punishable by fine or imprisonment, or both (18 USC §1001) and may jeopardize the validity of the application or any patent issuing thereon. All statements made herein are made of we own knowledge and are true and all statements that are made on information and belief are believed to be true.

Emily F. Gallagher
Emily F. Gallagher

2/24/06
Date

Louis M. Kindt
Louis M. Kindt

2/24/06
Date

Carey W. Thiel

Date

EXHIBIT A





Disclosure BUR8-2003-0200

Prepared for and/or by an IBM Attorney - IBM Confidential



Created By Carey W Thiel On [REDACTED] 06:40:21 AM MDT

Last Modified By Patricia L Blair On [REDACTED] 03:49:36 PM EDT

Required fields are marked with the asterisk (*) and must be filled in to complete the form.

*Title of disclosure (in English)

Scatterer Absorber EUVL Mask

Summary

Status	Final Decision (File)
Final deadline	
Final deadline reason	
Docket family	BUR9-2003-0178
* Processing location	Burlington
* Functional area	(Burlington - MD) All MD Inventors Located in Burlington
Attorney/Patent professional	Richard kotulak/Burlington/IBM
IDT team	Tom Faure/Burlington/IBM Emily Fisch/Burlington/IBM
Submitted date	[REDACTED] 12:42:39 PM MDT
* Owning division	MD
Incentive program	
Lab	Tivnan
* Technology code	101J3
PVT score	37

Inventors with a Blue Pages entry

Inventors: Carey W Thiel/Burlington/IBM, Louis Kindt/Burlington/IBM, Emily Fisch/Burlington/IBM

Inventor Name	Inventor Serial	Div/Dept	Inventor Phone	Manager Name
> Thiel, Carey W.	2A6165	29/OBSA	446-2024	Levy, Max G.
Kindt, Louis M.	4A9611	29/N4PV	446-1205	Watts, Andrew J. (Andy)
Gallagher, Emily E.	196200	29/ODOA	446-8010	Smolinski, Cecilia C.

> denotes primary contact

Inventors without a Blue Pages entry

IDT Selection

Attorney/Patent professional	Richard kotulak/Burlington/IBM
IDT team	Tom Faure/Burlington/IBM Emily Fisch/Burlington/IBM
Response due to IP&L	[REDACTED]

*Main Idea

To view the main idea for this disclosure, click on this doclink ---> (If you are prompted to enter a server name, please enter D01DB068/01/A/IBM)

*Inventor Questions

- * 1. Select the single most appropriate technology category for your invention from the following technologies list.
(101J3) Tech Tag 100 Solid State Technologies-101J3 Masks & Pellicles(Optical; X-Ray; Phase-Shift)

Comments

Are there any additional significant markets where the invention is likely to have impact?

Yes No

if Yes, please identify them:

Lithography

-
- * 2. Have you implemented the invention (e.g., made a prototype) or otherwise shown that it is workable?
 Yes No
if Yes, then what date

-
- * 3. Has the subject matter of the invention or a product incorporating the invention been offered for sale, or is it likely to be offered for sale, as part of an IBM product or service?

No known product plans within 2 years

Maybe; GA 1-2 years away

Yes; GA within 3-12 months

Yes; GA within 3 months

Yes; product has been announced

-
- * 4. Has the invention been commercially used (internally or externally) by IBM or another entity (e.g., included in or used to make products, or prototypes provided to a customer)?

Yes No

if Yes, please tell us the prototype/product, and when the use first started or is scheduled to start:

-
- * 5. In what type of product might a competitor include the invention?

EUVL mask.

What competitor(s) (indicate home country of such competitors if not United States)?

Intel, Infineon (Germany),

-
- * 6. How easily can the use of the invention by a third party be detected?

Undiscoverable; third party must admit use for IBM to know

Difficult; e.g.; with reverse engineering or examination of available code

With work; e.g.; using test cases; but not reverse engineering

Easily; by running & viewing product operation

Trivially; without purchase of product; e.g.; by reading product literature

Please propose how a test would be performed and what test methods may be required:

Standard bench marking would probably reveal the blank purchases and/or absence or presence of deposition capabilities. If a mask house is working directly with the uncoated substrate, it is probable that this method, or a similar one has been deployed. Physical examination of the finished EUVL mask would clearly reveal the mask type and whether the Scattering Absorber Mask (SAM) was being used

-
- * 7. Is the invention applicable to a standard?

Yes No

if Yes, what is the standard?

and Is IBM participating in the standard? Yes No

-
- * 8. Have you, or any of the other inventors, submitted this invention disclosure or a similar invention disclosure previously?

Yes No

If Yes, please provide the disclosure number: 1986 IBM Invention Disclosure "Black Hole Reflective Mask" Michael Hibbs, et al.

-
- * 9. Please list the invention disclosures (previously submitted or about to be submitted), products, patents, or publications that you and the other inventors feel are the most relevant to your invention (e.g., pertaining to the problem you are solving, including other solutions to the problem), be they from you or anyone else, or if not applicable, enter "None":
IBM Technical Disclosure Bulletin vol 32, no 7, Dec 1989 "Black Hole Reflective Mask"

-
- * 10. Was the invention made in the course of any activity that involved any other party, be it

• The government

Yes No

if Yes, enter the contract number

• A customer

(such as RFQ, IGS engagement)

Yes No

if Yes, describe the activity

• A development

partner

Yes No

if Yes, describe the activity

• As part of a

standards setting
activity

Yes No

if Yes, describe the activity

• Other persons not
employed by IBM

Yes No

if Yes, describe the activity

If Yes is answered to any of the above, please provide information sufficient to identify the activity (e.g., government contract number, company name, project name, alliance name, name of other party, client services principal, technical coordinator, etc.)

-
- * 11. Have you ever disclosed your invention to anyone outside IBM, or do you plan to do so in the future?
 Yes No

If Yes, please tell us whether the disclosure was (or will be) made, how made (or to be made), and whether or not there was (or is) a confidential disclosure agreement (CDA) in place covering the disclosure:

-
- * 12. If the invention relates to a product or service that is outside the scope of your business unit, please recommend IBM business unit(s), IBM location(s) or individual(s) within IBM that you think would provide a competent evaluation of your invention:

Final Evaluation Questions

A. Threshold Questions

1. Operability - Is implementation of the invention possible?

Yes

Reasons for above answer:

Demonstrated technique for creating light scattering absorber using special anisotropic silicon wet etch that

2. Novelty- Are one or more concept(s) of the invention novel over what is already known in the literature, existing commercial products, patents, and earlier IBM invention disclosures?

Yes

Reasons for above answer:

Totally new and different structure for EUV masks. Very different from current industry conventional structure

B. Valuation Questions

1. Adequacy of description:

Clear and complete as is

Reasons for answer:

2. Technical contribution of invention:

Major advance in technology

Reasons for above answer:

Radical change and potentially significant advantages over current status quo technology for EUV masks.

3. Describe the problem solved/benefit provided and the implementation cost of the invention compared to existing or reasonably expected alternatives:

Significant problem; substantial benefit - significant implementation cost

4. Are any alternatives to the invention available to those wishing to avoid its use?

No feasible alternatives

5. Describe the likelihood of use of the invention (answer each):

IBM's customers? Unlikely

IBM's suppliers/vendors? Possible

IBM's competitors? Possible

IBM? Possible

Reasons for above answer:

Unclear whether IBM will implement EUV lithography.

6. What % of third party products in the technical field will likely contain the invention?

< 25%

7. How long is the invention likely to be used in products by IBM or others?

10-15 years

8. How easily can use of the invention by a third party be detected?

Easily; by running & viewing product operation

Reasons for the above answer, including description of how use could be detected:

Quick gross visual examination of the mask.

Evaluation

This team evaluation was entered by Tom Faure/Burlington/IBM on [REDACTED]

What is the team's evaluation of this disclosure? Search

Date evaluated : [REDACTED]

Evaluation comments

We agreed that this should be rated a 1 for patent value and that we should file this at high priority

Final Evaluation History	Who made the final evaluation	Final evaluation date
Search	Tom Faure/Burlington/IBM	[REDACTED]

Search Information

Date sent: [REDACTED] *Target completion date: [REDACTED] Search results received date: [REDACTED]

Who was the search sent to (This area is to designate a Local Searcher name or WAIP):

*Search type: Patentability Clearance Validity State of Art

*Features to be searched:

A method (or structure) for forming a EUVL mask comprising the steps of:

depositing a hardmask and resist on crystalline Si;

transferring the pattern to the hardmask through plasma etch;

wet etching the crystalline Si with a KOH solution (or any other etch that produces appropriate sidewalls); and

depositing the Mo/Si multilayer onto the Si.

Search Office Information

Target completion date: [REDACTED] Search has been delayed Ship/Return date: [REDACTED]
Search conducted by Via
Comments

Final Decision

This decision was entered by Patricia L Blair/Burlington/IBM on [REDACTED]
Decision: File Status: N/A
PPM area: 100 - Solid State Technologies
Date of final decision : [REDACTED]

Additional filing information

Planned Filing date:

Filing comments:

Additional decision comments

Final Decision History

Entered on [REDACTED] by Patricia L Blair
File N/A [REDACTED] Docket Family: BUR920030178

Post Disclosure Text & Drawings

To add additional information related to this disclosure once it has been submitted, click the action button below and a new document will be opened for you to enter the new information. To view existing post disclosure information, double-click on the item in the list below (if there has been additional information entered), and the document will open for you to view.

Date entered Post disclosure comments and drawings (double-click an item below to view)

Form Revised ([REDACTED])



Main Idea for Disclosure BUR8-2003-0200
Prepared for and/or by an IBM Attorney - IBM Confidential

Archived On [REDACTED] 01:04:36 AM

Title of disclosure (in English)
Scatterer Absorber EUVL Mask

Main Idea of disclosure

1. Background: What is the problem solved by your invention? Describe known solutions to this problem (if any). What are the drawbacks of such known solutions, or why is an additional solution required? Cite any relevant technical documents or references.

Conventional EUVL masks are built by depositing a reflective surface onto an ultra low expansion (ULE) substrate. The reflective Bragg mirror is created with 40 alternating bilayers of Si and Mo, finishing with a protective Si cap. A buffer and absorber layer are then deposited on the multilayer stack. Additional layers can be deposited anywhere within the capping/buffer/absorber stack for different purposes, such as etch stops or conductive inspection/repair layers. The mask pattern is written onto a resist layer using standard mask patterning processes. A dry etch transfers the pattern through the absorber. Inspection and repair are performed and then the final pattern is transferred through the absorber to expose the reflective ML surface. Challenges inherent to this process are:

1. Maintaining the quality of that capping layer's reflective surface
2. Combining ideal chemical durability, adhesion, dry etch characteristics, and EUV characteristics; no known absorber/buffer stacks exist
3. Reducing the shadow effect created when the EUVL exposure light is incident on the substrate at the designed angle of 5 degrees. Since absorber stack height is finite, the edge of the raised absorber creates has a reduced contrast. This is a function of both the absorber and buffer layer thickness.

Our invention solves these three problems (all inherent to the conventional EUVL mask) by eliminating both the buffer and absorber layers of the mask stack.

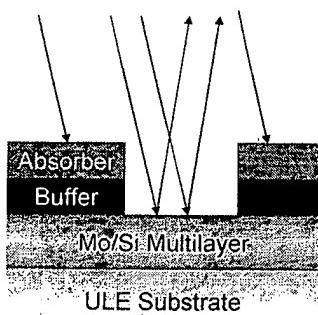


Figure 1. Schematic design of a standard EUVL mask in cross-section.

2. Summary of Invention: Briefly describe the core idea of your invention (saving the details for questions #3 below). Describe the advantage(s) of using your invention instead of the known solutions described above.

Our invention deploys a new type of absorbing region that is created before the multilayer is deposited. The patterning can be achieved by either roughening the surface of the mask substrate or etching into the substrate with sloped sidewalls. After multilayer deposition these patterned areas will act as the "absorber" because the reflective capabilities of the Mo/Si film stack are locally destroyed. However, as

we will discuss further, these regions don't actually absorbing the EUV radiation but rather deflecting the EUV radiation at an angle that will not be printed on the wafer.

We will focus this disclosure on an EUVL mask that is fabricated using sloped sidewalls as seen in Figure 2. In this figure the incoming EUV radiation at 5° is depicted as the black arrows, and normal EUV reflection is shown as blue arrows. The radiation that is reflected off the flat surface of the multilayer, shown with the blue arrows, will be printed on the wafer. In the patterned areas with the sloped sidewalls, the radiation is deflected at angle that will not print on the wafer. The out of plane reflections are depicted as the red arrows in Figure 2.

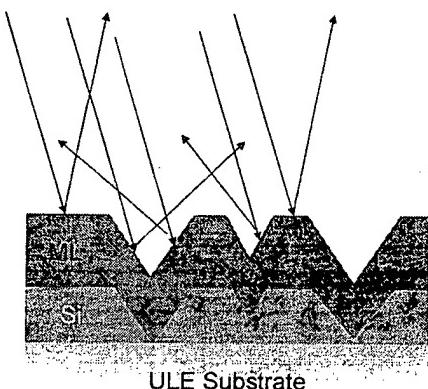


Figure 2. Schematic design of proposed EUVL mask design

Our invention eliminates the need for a buffer or absorber layer within the mask stack and solves the three problems listed in Section 1.

1. Since the multilayer is deposited as the final step in the mask fabrication the multilayer will not be subjected to plasma or wet etches and multiple cleans. Multilayer degradation should not be a problem with this mask and optimal reflectivity will be achieved, improving stepper throughput and pattern contrast.
2. With no absorber or buffer, there is no need to worry about an ideal film stack. The current mask is only comprised of the substrate (which may include a bonded crystalline Si) and the multilayer.
3. There should be no shadow effect during printing with this type of mask due to the lack of absorber and buffer layer.

And additional benefit is that the radiation is all reflected so that there is less heating of the EUVL mask (a major concern for image control and lifetime).

3. Description: Describe how your invention works, and how it could be implemented, using text, diagrams and flow charts as appropriate.

The example in this disclosure uses a substrate with a layer of crystalline Silicon. It is possible to attain a layer of crystalline Si on a quartz substrate by anodically bonding a silicon wafer to the quartz. This has been demonstrated by company x. Figure 3 outlines the process steps involved in making a mask of this type. The first step is to deposit a hardmask and resist. The desired pattern is written in the resist and the patterned is transferred to hardmask through plasma etch. The next step is to wet etch the crystalline Silicon with a KOH solution. The Si will etch along the [100] planes giving a sidewall slope of 54° . After the hardmask is stripped, the Mo/Si multilayer can be deposited onto the substrate.

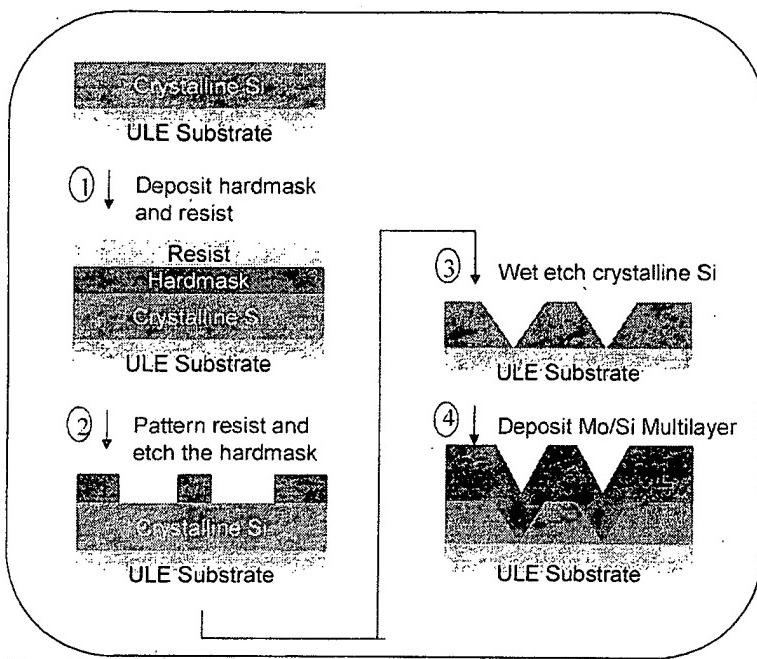


Figure 3: EUVL mask flow

To prove feasibility, a silicon wafer was coated with SiON hardmask and patterned with various designs. Figure 4 shows a silicon wafer that was patterned with contact design. The hardmask was stripped leaving the pattern in the Silicon. Although multilayer deposition wasn't performed, this still shows the feasibility of producing a mask of this type.

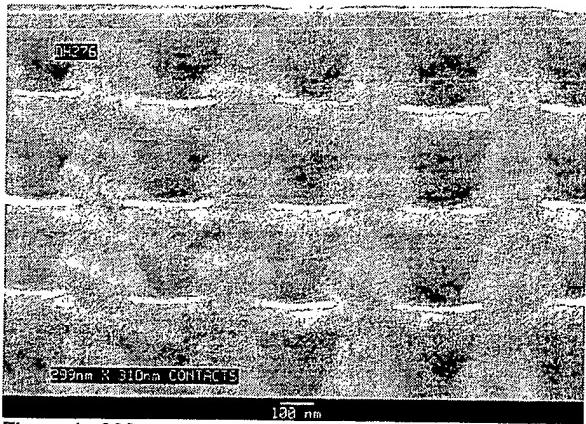


Figure 4: 300nm contact holes

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